Topic: Matter in our surrounding

Matter: It is be defined as anything that occupies space and possess mass. e.g. air is matter. It has mass and occupies space that we can check by filling a balloon with air and weighing it.

Characteristics of particles of Matter: The important characteristics of particles of matter are the following:

i) The particles of matter are very, very small.

ii) *The particles of matter have spaces between them:* There are some spaces between the particles of matter. The size and number of these spaces however differ form one kind of matter to another.

iii) *The particles of matter are continuously moving:* Particles are continuously moving as they possess kinetic energy. As temperature rises, the Kinetic energy increases and the particles move faster.

iv) *The particles of matter attract each other:* In other words, particles of matter have a force between them. This force keeps the particles together.

States of matter

Matter exists in three forms. They are called solid, liquid and gas. We can classify these constituents into three states. The bones and teeth are solid. The blood that flows in our veins is a liquid. Water is also present in our body which is a liquid. It accounts for about 70% of our body weight. the air that we breathe in is a gas.

Solid : It is defined as that form of matter which possesses rigidity, is incompressible and hence has a definite shape and a definite volume e.g. iron, wood, stone, sand etc.

Properties of solids

i) Solids have a fixed shape and a fixed volume.
ii) Solids possess rigidity i.e. they cannot be compressed much.
iii) Solids have high densities i.e. they are heavy.
iv) Solids do not fill their containers completely.
v) Solids do not flow.

Liquids: It is defined as that form of matter which possesses fluidity but is mostly incompressible and hence have a definite volume but no definite shape e.g. water, milk, petrol etc.

Properties of liquids

i) Liquids have a fixed volume but they have no fixed shape. They take the shape of the vessel in which they are placed.
ii) Like solids, liquids cannot be compresses much.
iii) Liquids have moderate to high densities. They are usually less dense than solids.
iv) Liquids do not fill the container completely.
v) Liquids generally flow.

Gases: It is defined as that form of matter which possesses fluidity but it is

highly compressible and hence has neither definite shape nor definite volume e.g. air etc.

Properties of gases

i) Gases have neither a fixed shape nor volume. Gases acquire the shape and volume of the vessel in which they are kept.

ii) Gases can be compressed easily.

iii) Gases have very low densities.

iv) Gases fill their container completely.

v) Gases flow easily.

Effect of change of temperature:

1.Change of state from solid to liquid: When heat is supplied to a crystalline solid its temperature increases and hence the kinetic energy of its constituent particles increases. Due to increase in kinetic energy, the particles start vibrating with greater speed. As the temperature is further increased, the energy supplied in form of heat overcomes the forces of attraction between the particles. At this stage the particles leave their fixed positions and start flowing. In other words, at this temperature the solid is converted into a liquid.

Thus the temperature at which a solid melts to become a liquid at atmospheric pressure is called melting point. This process of melting i.e. change of solid into liquid state is also called fusion. Also the amount of heat energy that is required to change 1kg of a solid into liquid at atmospheric pressure at its

melting point is called latent heat of fusion.

2.Change of State From Liquid To Gas:

When heat is further supplied to the liquid, the kinetic energy of the particles further increases as a result the interparticle distance increases and the forces of attraction between the particles weaken. Ultimately, a stage is reached when the interparticle distances become so large that the forces of attraction holding the particles become completely cut off. At this stage the particles become free to move about, in the whole space available to them and the liquid starts boiling i.e. liquid changes its state to vapours i.e. gaseous state. The temperature at which a liquid starts boiling at the atmospheric pressure is called its boiling point.

Also the amount of heat energy that is required to change 1kg of liquid into vapour at atmospheric pressure at its boiling point is called its latent heat of vapourization.

So, we can say that a substance is said to be a solid if its melting point is above room temperature under one atmospheric pressure.

A substance is said to be a liquid if its melting point is below room temperature under one atmospheric pressure.

A substance is said to be gas if its boiling point is below room temperature under one atmospheric pressure.

Sublimation:

Sublimation involves direct conversion of a solid into the gaseous state on

heating and vice versa on cooling without passing through the intervening liquid state.

Heating

Solid ⟶ Vapour (or gas)

Cooling

The solid which undergoes sublimation is called "sublime". The solid obtained by cooling the vapours of the solid is called "sublimate". The process of sublimation is very useful in the purification of such solid which sublime on beating and contain non-volatile impurities.

Effect of change Of Pressure

The interparticle distance can be decreased or increased either by increasing the pressure so that the particle come close together or by cooling the gas so that the kinetic energy of the gas particles decreases and then converted into solid either by cooling or by application of pressure or by the combined effect of both.

Evaporation

The phenomenon of change of liquid into vapours at any temperature below its boiling point is called evaporation.

Factors Effecting Evaporation

Temperature: The rate of evaporation increases on increasing the temperature of the liquid.

Surface area of the liquid: The rate of evaporation increases on increasing the

surface area of the liquid.

Humidity of air: When the humidity of air is low then the rate of evaporation is high and water is evaporated more readily.

When the humidity of air is high then the rate of evaporation is low and water evaporates very slowly.

Wind speed: The rate of evaporation of a liquid increases with increase in wind speed.

Textual Questions

1. *Give reasons for the following observation…………*
    a. The particles of matter posses kinetic energy and thus are constantly moving. At low temperature, the K.E. is low and hence the particles move slowly. But as the temperature rises, the kinetic energy increases accordingly and hence the particles move faster. Now the particles which are coming out as hot vapours out of hot sizzling food moves faster. Therefore, they easily reach us even when we are several meters away. On the other hand, the particles of vapours coming out of cold food travel slowly and hence do not reach us. Therefore to get the smell from cold food we have to go close to the food.

2. *A diver is able to cut through water in a swimming…………*?
    a. The particles of water are held together by forces of attraction. It is these forces of attraction which diver cuts through water in the

swimming pool.

3. *The mass per unit volume of a substance is……….*
    a. Honey and water are liquids but the mass of particles of honey is much higher and interparticle distance is much smaller than those in water. Therefore the density of honey is much higher than that of water. Both air and exhaust from chimneys are gases. Due to larger interparticle distances in them gases have lower densities than liquids. The density of exhaust from chimneys is expected to be higher than that of air. Chalk and iron are solids. But due to much smaller interparticle distances in them their densities are much higher than those of liquids and gases. Also in iron the particles are very closely packed but in chalk the particles are less closely packed. Therefore the density of iron is much higher than that of chalk. Thus, the overall order of increasing density is: air, exhaust from chimneys, cotton, water, honey, chalk and iron.

Comment upon the following:

Rigidity, compressibility, fluidity, kinetic energy and density.

Rigidity: It means tendency to maintain shape when some outside force is applied. Due to small interparticle distance and strong interparticle force of attraction, solids possess high rigidity.

Compressibility: It means tendency to decrease volume when some outside force is applied. due to large interparticle distance in gases, their volume

decreases when some pressure is applied on them. Therefore, gases possess high compressibility.

Fluidity: It means tendency to flow .Due to larger interparticle distances and weak forces of attractions, gases have the highest fluidity.

Kinetic energy:- It means energy possessed by particles due to motion. Due to large interparticle distances and weaker forces of attraction ,the particles of a gas have maximum freedom of movement. Therefore, particles of gas have the highest kinetic energy. Liquids have lower kinetic energy while solids have the least kinetic energy at any particular temperature.

Density: It means mass per unit volume. Since the particles of solids are closely packed, those of liquids are less closely packed while those of gases are loosely packed. Therefore solids have the highest density. Liquids have the lower densities than solids while the gases has the lowest.

Give reasons:

1. *A gas fills completely the vessel in which it is kept.*
    a. The particles of gas are constantly moving in all the directions with different speeds. Therefore, they do not have a fixed volume and hence completely fill the vessel in which they are kept.
2. *A gas exerts pressure oil the walls of the container?*
    a. The particles of a gas are constantly moving in all directions with different speeds. As a result of this random motion, the particles of a gas collide with one another and also against the walls of the

container. As a result of these collisions ,it exert force on the walls of the container. This force per unit area is called the pressure of the gas. Thus gases exert pressure due to the collisions of the particle of the gas with the walls of the vessel.

3. *We can easily move our hand in air hut to do same through a solid?*
   a. We can easily move our hand in air since the force of attraction between the particles of a gas. i.e. air is very weak and hence can be easily overcome for the movement of the hand. In contrast the particles of solid are closely packed and hence the interparticle force of attraction is very strong. As a result they cannot be easily overcome for movement of the hand.
4. *For any substance, why does the temperature remain constant during the change of state?*
   a. During the change of state of a substance at its melting point or the boiling point, temperature remains constant because the heat energy supplied to the substance is used up in overcoming the force of attraction. As a result, the thermometer does not show any rise in temperature till the entire substance undergoes change of state.
5. *Why does the water cooler cool better on a hot dry day?*
   a. A hot dry day means that temperature of the atmosphere is high and humidity of air is low. Both these factors increase the rate of evaporation and thus enormous cooling is produced.

6. *How does the water kept in earthen pot (malka) become cool during summer?*
    a. Due to the small holes or capillaries present in the walls of the earthen pot , the water oozes out slowly. As it comes on the outer surface of earthen pot (matka) it evaporates. The energy needed for evaporation is taken from the water kept in the earthen pot. As a result water kept in the earthen pot becomes cold.
7. *Why does our palm feel cold when we put some acetone or petrol or perfume on it?*
    a. Accetone. petrol or perfume have low boiling points. when these are put on the palm, they quickly evaporate. The energy needed for evaporation is taken from the palm. As result the palm feels cold.
8. *What type of clothes should we wear in summer?*
    a. In summer we perspire more. Therefore, to keep our body cool we must wear cotton clothes. Since cotton clothes are good at absorbing water, they absorb the sweat quickly and expose it to the atmosphere for easy evaporation. Since evaporation produces cooling therefore, cotton help us in keeping our body cool.
9. *Liquids generally have lower density as compared………….*
    a. In general, liquids have lower density than solids therefore, ice is expected to be heavier than water. However, ice has lower density than water because it has cage like structure which has a lot of

vacant space in it. The number of these vacant spaces is comparatively less in water and hence density of water is more than ice. Therefore, because of lower density of ice, it floats on water.

Do Q12 & Q13 yourself.

14. For any physical state, why does……….

a. Temperature remains constant during the change of state because the heat supplied during the change is used in overcoming the intermolecular forces between the particles of that state.

15. Suggest a method to liquefy atmospheric gases.

a. Atmospheric gases can be liquefied by cooling under pressure.

16. Why does a desert cooler cools better on a hot dry day?

a. On a hot dry day, the humidity is less and therefore, rate of evaporation is more. Since evaporation uses cooling, therefore, as the rate of evaporation is more on a hot dry day , desert cooler cool better.

17. Why are we able to sip hot tea or milk faster from saucer rather than a cup?

a. The surface area of hot tea or milk in a saucer is more than in a cup. Because of larger surface area, cooling will be more rapid in a saucer than in a cup. Hence we are able to sip hot tea or milk faster from a saucer rather than a cup.

18. **Do it yourself.**

19. Give reason for the following observations:

a) Naphthalene balls disappear with time without leaving any solid.

Naphthalene is volatile solid and has a tendency to sublime. Therefore, it changes into vapours completely which disappear into the air and hence no residue is left.

b) We get the smell of perfume sitting several meters away.

This is because perfume contains volatile solvent which carries pleasant smelling vapours. They diffuse quite fast and can reach to people sitting several meters away.

20 & 21: Do it yourself.

22. Give two reasons to justify

a) Water at room temperature is a liquid.

i) Water is liquid at room temperature because it has fixed volume but no fixed shape.It even takes the shape of the container.

ii) Water can flow easily.

b) An iron almirah is a solid at room temperature

i) An iron almirah is a solid because it has a definite shape.

ii) It has a fixed volume.

23. *Why is ice at 273K more effective in cooling than water at the same temperature?*

Ice at 273K is more effective in cooling than water at 273K because in ice, the molecules have lower energy as compared to particles in the liquid water at the same temperature.

24. What produces severe burns, boiling water or steam?

Steam produces more severe burns as compared to boiling water. This is because, molecules in steam have more kinetic energy than in boiling water. Moreover, latent heat of vapourisation of steam is more than that of boiling liquid. Therefore, it produces more severe burns.

Do Q25 yourself.

Topic: Is Matter Around Us Pure

Pure substance: It may be defined as a substance which contains only one kind of atoms or molecules. Pure substance is throughout same because it consists of only one kind of particles. These particles are similar to one another and can't be separated into simpler particles by any physical process. All elements and compounds are pure substance (H_2, C_2 , O_2 etc)

Impure substance: They may be defined as the substances which contain two or more different kinds of particles which are not combined chemically but are mixed together in a variable proportion. They have a variable composition and no definite formula can be given to the impure substances.

Elements: Robert Boyl was the first scientist who used the term element in 1961. An element is defined

as the simplest form of substance that contains only one kind of atoms which are same in all respect (size, shape, mass etc.) However atoms of different elements are different from one another. Elements are found to exist in all the states of matter i.e solid, liquid and gas.

Example of solid elements: Sodium. Potassium, and Gold.

Example of liquid elements: Mercury, Bromine.

Example of gaseous elements: Hydrogen, oxygen, and nitrogen

Classification of elements based on physical and chemical properties:

On the basis on physical properties elements have been classified into three types: Metals, Non Metals, and metalloids.

Properties of metals:

i) These are lustrous i.e. they have a shiny appearance.

ii) These are malleable i.e they can be hammered or beaten to form thin sheets without breaking.

iii) These are ductile i.e they can be drawn into thin wires.

iv) These are good conductors of heat and electricity.

v) These are generally hard but hardness varies from one metal to other.

vi) These have a high tensile strength i.e. they can withstand large force without breaking

vii) These generally have high melting and boiling points.

viii) These generally have high densities.

ix) These are sonorous. i.e they make a ringing sound when hit.

Metalloid:

Elements which have properties in between those of metals and non-metals are called as metalloids. These elements show some properties of metal and some properties of non-metals e.g. silicon, germanium.

Physical properties of non-metals:

1. They have dull appearance.
2. They are non-ductile.
3. They are non malleable but are brittle i.e they break easily.
4. They are bad conductors of heat and electricity.
5. They are generally soft except diamond which is extremely hard.
6. They are not strong.
7. They have low densities.
8. They have comparatively low melting and boiling points.
9. They are not sonorous.

Mixture:

It is a material which consists of two or more pure substances which are not chemically combined but are physically mixed in any proportion e.g. sea water, air etc.

Types of mixtures:

1) Homogeneous mixture: A mixture is said to be a homogeneous if all the components of mixture are mixed uniformly and there are no boundaries of separation between them. In other words a homogeneous mixture consists of only

one phase e.g. air, alloys etc.

2) Heterogeneous mixture: A mixture is said to be heterogeneous if all the components of mixture are not thoroughly mixed and there are visible boundaries of separations between them. It does not have a uniform composition throughout e.g. a mixture of sugar and sand, mixture of oil and water.

Physical properties of mixture:

1) It may be homogeneous or heterogeneous.
2) Its composition is variable.
3) It does not have a definite melting and boiling point.
4) Energy is neither absorbed nor evolved during the formation of mixture.
5) The components of mixture can be separated by simple physical methods.
6) The properties of mixture are the properties of its constituents.

Compounds: - It is defined as pure substance made up of two or more elements chemically combined in a fixed ratio by mass e.g. H_2O, CO_2, etc.

Properties of compound:

1. It is always made up of same elements combined together in a fixed ratio by mass.
2. It has a definite molecular formula and a fixed melting and boiling points.
3. Energy in the form of heat or light is usually evolved or absorbed during the formation of compounds.
4. It cannot be separated into its components by the simple physical methods.
5. The properties of a compound are entirely different from its components.
6. Compound is always a homogeneous substance.

Physical changes:

The changes in which only physical properties of the substance change but no new substances are formed are called physical changes. During physical changes the substances do not change their identity but only some physical properties such as

physical state, shape and size changes. These physical changes can be reversed easily e.g. melting of ice, preparation of solution.

Chemical changes:

Those changes in which new substances are formed are called as chemical changes. During a chemical change, chemical properties, and chemical composition of the substance is changed.

The substance loses its identity and gets converted into entirely different substances. The chemical changes are permanent or irreversible, i.e. burning of paper, rusting of iron.

Solution:

It is defined as a homogeneous mixture of two or more chemically non reacting substances whose composition can be varied within limits. If a mixture is to be called solution, it must satisfy the following two conditions:

1. The components should be non- reacting.
2. Mixture should be homogenous.

True solution: Solution is said to be a true solution if the solute particles are so thoroughly mixed with the solvent that we cannot distinguish them from one another.

Aqueous solution: A solution in which H_2O acts as a solvent is called as an aqueous solution e.g. solution of common salt and H_2O.

Non-aqueous solution: A solution in which solvent is other than H_2O is called as non aqueous solution e.g. solution of iodine in alcohol.

Components of the solution:

1. Solute: The component of the solution which is present in small amount is called a solute.
2. Solvent: The components of solution which is present in large amount is called solvent.

Types of solution:

Solid solutions: In solid solutions , solvent is a solid while as solute can be either solid, liquid or gas e.g

Alloys, hydrated salt.

Liquid solution: in a liquid solution, solvent is a liquid while solute can be either a solid, liquid or a gas e.g. a solution of alcohol in H_2O, solution of sugar in H_2O aerated drinks.

Gaseous solution: In gaseous solution solvent is a gas while solute can be either solid, liquid or gas e.g. air,

clouds etc.

Name of solution	**Solute**	**Solvent**	**Examples**
Solid Solutions			
i) Solid in solid	Solid	Solid	Alloys
ii) Liquid in solid	Liquid	Solid	Hydratedsalts
iii) Gas in solid	Gas	Solid	Gas adsorbed on metal surface
Liquid Solutions			
i) Liquid in liquid	Liquid	Liquid	Vinegar sol
ii) Solid in liquid	Solid	Liquid	sugar sol
iii) Gas in liquid	Gas	Liquid	Aerated drinks
Gases solution			
i) Solid in gas	Solid	Gas	Iodine in air
ii) Liquid in gas	Liquid	Gas	Clouds, fog
iii) Gas in gas	Gas	Gas	Air

Properties of solution:

1) It is a homogenous mixture.
2) The components of a solution do not chemically react with one another.
3) A solution may be coloured or colourless.
4) The particles of solution are smaller than 1nm in diameter. So, they can't be seen by naked eyes or

'. even under a microscope.

5) The solute particles do not scatter a beam of light passing through the solution. Therefore, the path of light is not visible in a solution.
6) The solute particles of a solution pass through the filter paper, thereby, showing that they are smaller
than the pores of filter paper.
7) When the solution is allowed to stand undisturbed, the solute particles do not settle down. This shows that the solutions are stable.

Concentration of a solution:

It is the amount of the solute present in a given solution. The solution having small amount of solute is said to have a low concentration and is known as dilute solution. The one having large amount of solute is said to have high concentration and is known as concentrated solution. The most common way of expressing concentration of solution is the percentage method and can he expressed in a different ways:

i) Mass% ii) Mass%

Mass Volume

Formulas:

$$\text{Concentration of solution} \quad \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

Concentration of solution Mass of Solute x 100

Volume of sol.

1) *Calculate the concentration of a solution if it contains 10gm of solute and 90gms of solvent.*

Sol: Mass of solute = l0 gm

Mass of solvent = 90gm

Mass of solution = 10 + 90

= l00gm

Concentration of solution = Mass of the solute

x 100 Mass of solution

= 10/100x100

= 10%

2) *If 110g of salt in present in 550g of solution. Calculate the concentration.*

Sol: Mass of solute = l10g

Mass of solution = 550gms

.'. Concentration of solution = Mass of solute

x100 ---------

Mass of solution

= 110/550x100

= 20%

3. A solution contains 50ml of alcohol mixed with 150ml of water. Find its concentration.

Sol: Volume of solute = 50 ml

Volume of solvent = 150 ml

Volume of solution = 150ml + 50ml

= 200ml

$$\text{Concentration of solution} = \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

= 50/200x100 = 25%

***Solubility*:**

The maximum amount of solute in grams which can be dissolved in l00gm of solvent at a given temperature to form a saturated solution is called the solubility of the solute in that solvent at a particular temperature.

Effects of temperature and pressure on solubility:

The solubility of solids in liquids usually increases on increasing in temperature and decreases on decreasing the temperature.

The solubility of solids in liquids remains unaffected by the change in pressure.

The solubility of gases in liquids usually decreases on increasing the temperature and vice versa.

The solubility of gases in liquids increases on increasing the pressure and decreases on decreasing the pressure.

***Saturated solution*:** A solution which contains the maximum amount of solute dissolved in a given quantity of solvent at a given temperature and which cannot dissolve any more solute at that temperature is called saturated solution.

Unsaturated solution:

A solution in which more quantity of solute can be dissolved without raising its temperature is called unsaturated solution.

Super Saturated Solution:

A solution which temporarily contains more solute than the saturation level at a particular temperature is called super saturated solution.

Effects of heating or cooling on saturated solution:

1. If the saturated solution is heated it becomes unsaturated because the solubility of solute increases on heating and more of the solute can be dissolved on raising the temperature of the solution.
2. If the saturated solution is cooled then some of its dissolved solute will separate out in the form of solid crystals because the solubility of solute decreases on cooling. ' ;

Suspension:

It is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium e.g. suspension of calcium hydroxide in water etc. '

Properties of suspension:

1. It is a heterogeneous mixture.
2. The solid particles of a suspension are so large that they are visible to the naked eye.
3. The particles of a suspension scatter a beam of light passing through it and make its path visible.
4. Suspensions are unstable. The solid particles of a suspension settle down when it is allowed to stand undisturbed for some time.
5. The particles of a suspension cannot pass through a filter paper.
6. Suspensions are either opaque or translucent.

Colloidal Solution:

Solution in which the size of particle lies in between those of true solution and suspension are called colloidal solution or colloides.

Properties of collides:

1. It is a heterogeneous mixture consisting of two phases called dispersed phase and dispersion medium.

2. These are stable.
3. The size of colloidal particles lie between those of true solution and suspensions.
4. When colloidal solutions are placed under an ultra microscope the particles are seen to be
   continuously moving in a zig-zag path which is called
   Brownian motion.
5. The colloidal particles are big to scatter light passing through them which makes the path of light visible. This scattering of beam of light by colloidal particles is called as Tyndall effect.
6. The particles carry charge.

Dispersed phase	Dispersion medium	Type	Example
Solid	Solid	Solid sol.	Coloured gem stones
Solid	Liquid	**	Muddy H2O, paints
Solid	Gas	Solid aerosol	Smoke, dust, storm
Liquid	Solid	Gel emulsion	Telly, cheese
Liquid	Liquid	Aerosol	Milk , face cream
Liquid	Gas	Solid foam	Fog, clouds, sprays Pumice stones, rubber
Gas	Solid	Foam	Soap, lather, shaving cream
Gas	Liquid		

Dispersed Phase:

The solute like component which has been dispersed throughout in a solvent like

medium is called dispersed phase.

Dispersion medium:

The solvent like medium in which the dispersed phase has been distributed is called the dispersion medium.

Emulsion:

It is a type of solution in which the dispersed phase as well as dispersion medium is a liquid e.g. milk etc.

Types of emulsion:

Oil in water emulsions: In these emulsions oil is the dispersed phase and water is dispersion medium.

Water in oil emulsions: In these emulsions water is the dispersed phase and oil is dispersion medium.

Emulsifiers:

The substances which are added to stabilize emulsions are called emulsifiers. They stabilize emulsions by reducing the surface tension of water.

Techniques of separation:

Evaporation:-

This is the method used to separate non-volatile components (solutes) that are dissolved in volatile solvents. In this method, we heat a homogeneous mixture which leads to the evaporation of solvents leaving behind the

Non- volatile solute. For example this technique is used on a commercial scale to obtain common salt from sea water or lakes containing common salt.

Centrifugation:

Sometimes the solid particles in liquid mixture are very small and thus easily pass through filter paper. Therefore, such particles can't be separated by filtration technique. Such mixtures can be easily separated by the technique of centrifugation. This technique is based upon a principle that when the mixture is rotated at high

speed, the lighter particles stay on the surface of liquid while the heavier particles are forced to the bottom of liquid. The machine used to carry out the process of centrifugation is called centrifuge e.g. when milk is rotated at high speed in centrifuge the lighter fat particles come to the surface in the form of cream, while the heavier particles of milk are forced to come to the bottom. As the result separation occurs, the cream is collected at the outlet provided near the top of centrifuge. While the milk is collected through the outlet provided near the bottom of the machine.

Applications of centrifugation technique:

1.This technique is used in diagnostic laboratories for blood and urine tests.

2.It is used in dairies and homes to separate butter from cream.

2. Centrifugation technique is also used in washing machines to squeeze out water from wet clothes.

Miscible liquids:

The pair of liquids which mix well with each other are called miscible liquids.

Immiscible liquids:

The pair of liquids which do not mix with each other are called immiscible liquids it.

Separation using a separating funnel:

This method is used to separate two immiscible liquids. These liquids form a heterogeneous mixture and they can be separated it to constituents by using separating funnel. This technique is based upon the principle that when a mixture of two immiscible liquids is allowed to stand, they separate out into two separate layers depending upon their densities e.g. mixture of kerosene oil and water is separated using this technique. We pour the mixture of kerosene and water in a separating funnel. It is allowed to stand for sometime so that two separate layers are formed. The kerosene oil being lighter than water forms the upper layer while the water being heavier forms lower layer. The boundary of separation of two liquids is clearly visible. Now place the beaker beneath the funnel and open stop cock. The lower

layer of water is run out carefully. Close the stop cock as soon as the oil layer reaches the stop cock. Now remove the breaker containing water and replace it by another beaker. Once again open the stop cock and pour out the upper kerosene oil layer.

Applications of this technique:

It is used to separate the mixture of two immiscible liquids like benzene and water, chloroform and water, ether and water.

Sublimation:-

The process of sublimation is used to separate sublime volatile components from the non-volatile components of a mixture. Example a mixture containing ammonium chloride and common salt is separated by this technique.

***Crystallization*:**

Crystals are the purest form of substance having definite geometrical shapes. The process by which an impure compound is converted into its crystals is known as crystallization. This process is based upon the principle that when a crystal is formed, it tends to exclude the impurities which remain in the solution e.g. if we take about 5gms of impure copper sulphate and dissolve it in a minimum amount of water in a China dish.The solution is then filtered to remove insoluble and suspended impurities. Then the filtrate is evaporated in a China dish so as to get a saturated solution. 'The hot saturated solution is allowed to stand undisturbed for few hours due to which crystals of pure copper sulphate separate out. These crystals are separated by filtration through an ordinary funnel and the filtrate left after the separation of crystals is called as mother liquor.

Applications of crystallization:

1. It is used to obtain pure salts from the impure samples.
2. The salt we get from sea water contains a number of impurities. To remove these impurities process of crystallization is used.

Advantages of crystallization over evaporation:

During evaporation, the solution is heated to dryness. During this treatment some solids get decomposed.

When the solution is evaporated, the impurities get deposited along with the solid and thus contaminate the solid. In contrast when the solution is allowed to stand for crystallization, crystals of pure solid separate out leaving behind impurities in the solution.

Chromatography:

It is most modern and versatile method used for the separation, purification and testing the purity of inorganic and organic compounds. It was discovered by a Russian botanist in 1906 named as TS Wett.

Types of chromatography:

i) Column chromatography
ii) Thin layer chromatography
iii) Gas liquid chromatography
iv) High performance liquid chromatography
v) Paper chromatography

Principle of chromatography:

We know that two or more substances may be soluble in the same solvent but their solubilities are usually different. Thus, when a solvent is allowed to pass over mixture of such substances, the substance which is more soluble in solvent moves faster and thus gets separated from oilier substances in mixture which moves slowly. Thus separation of different components of mixture by chromatography is based upon their different solubility in the same solvent.

Applications of the Chromatography:

1. It is used to monitor the progress of a reaction.
2. *It* is used to separate different colored substances present in dyes and natural

pigments.

3. It is used to separate and identify the amino acids obtained by hydrolysis of proteins.
4. It is used to detect and identify drugs present in the blood of criminals in forensic science.

Distillation:

It involves conversion of liquid into vapours by heating followed by condensation of vapours thus produced by cooling.It is used for the separation of components of a mixture containing two miscible liquids which boil without decomposition and have sufficient difference in their boiling points.

Principle of distillation:

The separation is based upon the principle that at the boiling point of more volatile liquid of mixture, the vapours almost exclusively consists of the more volatile liquid. Likewise at the boiling point of less volatile liquid, the vapours almost consist of less volatile liquid since the more volatile liquid has distilled already over. Thus the separation of liquid mixture into individual components can be achieved at their respective boiling points. The more volatile component distills first while the less volatile component gets distilled over afterwards.

Applications of distillation:

It is used to separate the mixture of two miscible liquids e.g. ether and toluene, benzene and toluene etc.

Fractional distillation:

If the boiling points of two miscible liquids of the mixture are very close to one another, the separation can't be achieved by simple distillation method. This is due to the reason that at the boiling point of the more volatile liquid of the mixture there will be sufficient vapours of the less volatile liquid as well. As a result, both the liquids of the mixture will distill together and their separation can't be achieved. The separation of such a liquid mixture into individual components can achieved by

fractional distillation which involves repeated distillations and condensations. Distillation is carried out using a fractionating column.

Fractional distillation of air:

Air is a homogeneous mixture of many gases which can be separated by fractional distillation. Air is cooled and compressed by applying pressure and decreasing temperature. Air is compressed to form liquid air called liquefied air liquid. Air is subjected to fractional distillation and different gases are separated according to their boiling points.

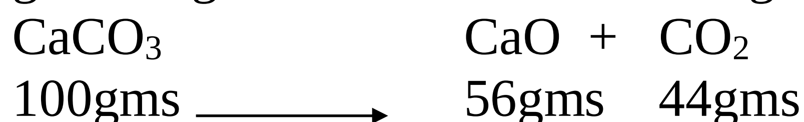
Topic: Atoms and Molecules

Atom: The smallest particles of matter that have independent existence. These are constituent particles of elements.

Laws of Chemical Combination: Whenever reactants combine together to form the products or the elements combine together to form the compound, they do so according to certain laws. These laws are called laws of chemical combination.

Laws of Conservation of Mass: This law was put forward by Antoine Lavoisier in 1774. It states as follows:

Mass can neither be created nor destroyed in a chemical reaction. In other words, in any chemical reaction, the total mass of the reactants is equal to the total mass of the products e.g. calcium oxide and carbon dioxide. It is found that if 100gm of calcium carbonate is heated, it gives 56g of calcium oxide and 44gms of CO_2. Thus, for the reaction



$CaCO_3$ → CaO + CO_2

100gms → 56gms 44gms

Total mass of reactants = Total mass of the products. This shows that no mass is created or destroyed in chemical reaction.

Experiment to verify law of conservation of mass:

Take a clean conical flask fitted with a cork. Also take a small test-tube and tie a thread to its neck so that it can be suspended in the flask. Weigh the flask, cork and tube together. Prepare the solution of ($BaCl_2$) Barium

chloride and sodium sulphate (Na_2SO_4). Take a small amount of barium chloride solution in the conical flask and a small amount of sodium sulphate solution in the test tube. Suspend the test tube in the

flask with the thread. Weigh the complete apparatus. Subtract the mass of the empty apparatus. The difference will give the mass of the reactants taken. Now, loosen the cork so that the thread is loosened and the test tube falls into the flask. As a result, the solution of the tube mixes into the solution of the flask. A white precipitate appears in the flask due to the following reactions:



$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + NaCl_2$

Weigh the complete apparatus again along with the contents. Subtract the initial mass of the empty apparatus. The difference will now give the total mass of the products. We observe that mass comes out to be same as it was before the reaction. This proves the law of conservation of mass.

Law of constant Composition/ Definite Proportion:

This law deals with the composition of elements present in a given compound. It was put forward by J.L. Proust in 1799. It states as follows:

A chemical compound found is always made up of the same elements combined together in a fixed ratio by

mass e.g. water obtained from any country is always made up of same elements i.e. hydrogen and oxygen combined together in the same fixed proportion i.e. 1:8 by mass.

This law helps to calculate the percentage of any

element in the given compound, using the following

expression:

$$\% \text{ of an element in the compound} = \frac{\text{Mass of that element}}{\text{Mass of compound}} \times 100$$

Numerical:

1. *When 4.2gm of sodium carbonate is added to a solution of hydrochloric acid HCl weighing l0g it is observed that 2.2g of CO_2 is released in the atmosphere. The residue left behind is found to weigh 12.0g. Show that these observations are in agreement with the law of conservation of Mass.*

Sodium hydrogen carbonate + hydrochloric acid Sodium → sodium chloride + water + CO_2

Mass of products → Mass of CO_2 + Mass of residue

4.2g + 10.0g → 14.2g

Thus Mass of Reactants = Mass of Products

2. *What mass of silver nitrate will react with 5.85° of sodium chloride to produce 14.35° of silver chloride and 8.5g of sodium nitrate if the law of conservation of mass is true?*

Sol: The reaction is:

Silver nitrate + Sodium chloride →Sodium nitrate + silver chloride

If law of conservation of mass is true

Total mass of reactants = Total mass of products

i.e. mass of $AgNO_3$ + NaCl = Mass of AgCl+ Mass of $NaNO_3$

Mass of $AgNO_3$ = ?

Mass of AgCl = 14.35g

Mass of NaCI = 5.85g

Mass of $NaNO_3$ = 8.5g

? + 5.85g = 14.35g + 8.5g

? + 5.85 = 22.85g

? = 22.85g - 5.85g

? = 17.0g

∴ Mass of $AgNO_3$ = 17.0g

3. *Copper oxide was prepared by two different methods in one case, 1.75g of the metal gave 2.19g of oxide. In second case, 1.14g of the metal gave 1.43 g of the oxide. Show that the given data illustrates the law of constant proportion.*

Sol. *Case I*

Mass of copper = 1.75g

Mass of copper oxide = 2.19g

% of copper in the oxide = $\frac{\text{Mass of copper}}{\text{Mass of copper oxide}} \times 100$

= 1.75/2.19 x 100

= 79.9%

% of oxygen = 100 - 79.9

= 20.1%

Case II:

Mass of copper oxide = 1.43g

Mass of copper = 1.14g

% of copper in the oxide = 1.14/1.43 x 100

= 79.9%

% of oxygen = 100 - 79.9

= 20.1%

Thus, CuO prepared by any of the given methods

contains copper and oxygen in the same proportion by mass. Hence it proves law of constant proportion.

4. *Calculate the mass of carbon present in 2g of CO_2?*

Sol: CO_2 contains carbon and oxygen in the fixed proportion by mass, which is 12:32 i.e. 3:8.This means that 3g of carbon combines with 8g of oxygen to form 11 g of CO_2. In other words,

11g of CO_2 contain C = 3g

2g of CO_2 contain C 3/11 x 2 = 0.545g

Dalton's Atomic Theory:

This theory was put forward by John Dalton in 1808. According to this theory:

1. All matter whether an element, compound or a mixture is made up of extremely small particles called atoms.
2. Atoms of the same elements are identical in all respects i.e. size, shape, mass and properties.
3. Atoms of the same or different elements have different sizes and masses and also possess different properties.
4. Atoms of the different elements combine together to form molecules or compounds.

5. When atoms of different elements combine together to form compounds, they do so in a simple whole number. Ratio such as 1: 1, 2:1, 2:3 etc.
6. Atoms of two different elements may combine in different ratios to form more than one compound e.g. carbon and oxygen may combine to form CO and CO_2 in the ratios of l : l and 1: 2 respectively.

7. The number and kind of atoms in a given compound is always fixed.

8. Atom is the smallest particle that takes place in a chemical reaction. In other words, whole atoms take part in the chemical reaction.
9. An atom can neither be destroyed nor created i.e. atom is indestructible.

Explanation Laws of Chemical Combination by Dalton's Atomic Theory:

1. *Explanation of Law of Conservation of Mass:* According to Dalton's theory, matter is made up of atoms. Atom can neither be created nor destroyed. Hence, matter can neither be created nor destroyed.

   Also atom is the smallest particle that takes part in a chemical reaction. Thus, a chemical reaction involves only rearrangement of atoms i.e. total number and kind of atoms remain the same. As atoms can neither be created nor destroyed and the atoms have definite masses thus, total mass remains unchanged during a chemical reaction.
2. *Explanation of Law of Constant Proportion:*

   According to one of the postulates of Dalton's atomic theory, the number and kind of atoms in a compound is fixed. As the kind of atoms is fixed, this implies that the compound is always made up of the same elements. Further, as the number of atoms of different elements in the compounds. As atoms have fixed masses, this means that in the compound, the elements are combined in a fixed ratio by mass.

Limitations of Atomic Theory Or Modern Atomic Theory:

Atom is no longer considered as the smallest indivisible particle. It contains electrons, protons and neutrons. Atoms of the same element

may have different masses e.g. there are two types of atoms of chlorine with masses 35 and 37. Such atoms of the same element with different mass numbers are called isotopes. Atoms of different elements may have same masses e.g. atoms of potassium and calcium are known with the same mass number (40) such atoms of different elements with same mass numbers are known as isobars. Substances made up of the same kind of atoms may have different properties e.g. charcoal, diamond and graphite all are made up of carbon atoms have different physical properties.

The ratio in which the different atoms combine to form compound may be fixed and integral but may not be simple e.g. sugar molecule contains C_{12} $H_{22}O_{11}$ i.e.

CHO are in the ratio of 12:22:11.

Atom: It is defined as the smallest particle of an element which may or may not be able of free existence. It is the smallest particle that takes part in a chemical reaction.

Atomic Mass: The atomic mass of an element is the relative mass of its atoms as compared with the mass of an atom of carbon- 12 isotope taken as 12 units.

It may be defined as the number of times an atom of any element is heavier than $1/12^{th}$ of the mass of an atom of C12 isotopes.

Atomic Mass Unit: It may be defined as the $1/12^{th}$ of the mass of an atom of carbon 12 isotope on the atomic scale i.e. 1 amu = 12^{th} of mass of C-12 isotopes.

Molecule of an element:

It is a group of two or more atoms which are held together strongly by

some kind of attractive forces. Such an attractive force holding the atoms together is called a chemical bond.

Molecule of an element: Molecule of an element means one, two or more atoms of the same element existing
as one species in free state.

i) *Monoatomic molecules*: - Noble gases like helium, neon exist as single atoms i.e. He, Ne. etc. Hence, their molecules are monoatomic.
ii) *Diatomic molecules*: These are the molecules in which the two atoms join together to form a molecule e.g. H_2O etc.

iii) *Tri atomic molecules*: These are the molecules in which three atoms join together to form a molecule e.g. O_3 (ozone).
iv) *Tetra atomic molecules*: These are the molecules in which four atoms join together to form a molecule e.g. P_4 (phosphorus).
v) *Pent atomic molecules:* These molecules consist of 5 atoms e.g. CCl_4, HNO_3, CH_4 etc.
vi) *Polyatomic Molecules*: Molecules containing more than four atoms are generally called polyatomic e.g. S_8 (sulphur).
vii) *Atomicity*: The number of atoms present in one molecule of the substance is called its atomicity.

viii) *Molecules of a compound*: Molecules of a compound means two or more atoms of different elements combined together in a definite proportion by mass to form a compound.

Classification of Molecules of a Compound:

1. Diatomic molecules: The molecules consist of two atoms either same or different e.g.: H_2, N_2,O_2,HCl etc.

2. Tri atomic molecules: These molecules consist of three atoms e.g. O_3, CO_2, H_2O. NO_2, SO_2 etc.
3. *Tetra atomic molecules:* These molecules consist of four atoms e.g. NH_3, P_4, PCl_3, SO_3 etc .

Naming the molecule: In case of molecules of elements, atomicity is generally not indicated in the name e.g. H_2 is called hydrogen molecule, O_2 is called oxygen

molecule. According to the latest system they are named as dihydrogen and dioxygen.

Naming molecules of compounds: The binary compounds that is the compounds that are formed of two elements follow certain laws while we name them e.g. in HCl.

i. The less the electronegative element is named first followed by the more electronegative elements e.g. hydrogen chloride.
ii. The name of the more electronegative element is changed to end in - ide e.g. hydrogen chloride (HCL) etc.
iii. Common names are quite after used instead of scientific names e.g. H_2O is called water and (not hydrogen and oxide), NH_3 is called ammonia

    (and not nitrogen trihydride) and so on.
iv. The number of atoms of each element is generally indicated in the name by adding the prefix di, tri, tetra, penta etc e.g. N_2O_5 is called dinitrogen pentoxide, PCl_3 is called phosphorous trichloride.
v. If the first element of the molecular compound is hydrogen, the number of the atoms is not written in the name e.g. H_2S is called

hydrogen sulphide and not dihydrogen sulphide.

vi. *Molecular Mass*: Molecular mass of a substance is the average relative mass of its molecules as compared with that of an atom of C-12

vii. Isotope taken as 12. In other words, molecular mass of a substance represents the number of times the molecule of that substance is heavier than $1/12^{th}$ of the mass of an atom of C-12 isotope.

viii. *Calculation of Molecular Mass:* As molecules are made up of two or more atoms of the same or different elements and each atom has a definite atomic mass, therefore, molecular mass of a molecule of a substance can be calculated by adding atomic masses of all atoms present in one molecule of the substance e.g. A molecule of hydrogen has the formula H_2.It contains two atoms of hydrogen. Hence molecular mass of hydrogen =

2 x atomic mass of hydrogen = 2 x 1.0 u = 2.0 u. A molecule of oxygen has the formula O_2. Hence molecular mass of oxygen = 2 x atomic mass of oxygen= 2 x16u = 32u.

Q) Calculate the molecular mass of the following:

Solution : Molecular mass of $C_{12}H_{22}O_{11}$

Atomic mass of $C_{12}H_{22}O_{11}$ is

12 x Atomic mass of C + 12 x atomic mass of H + 11 x atomic mass of O

=12 x 12.0u + 12 x 1.0u + 11 x 16

= 144 + 12 + 176=332u

Calculate the molecular mass of $Al_2(SO_4)_3$ Do it yourself.

Ions: An atom or a group of atoms which carries positive or negative charge is called an ion. The ion carrying positive charge is called a

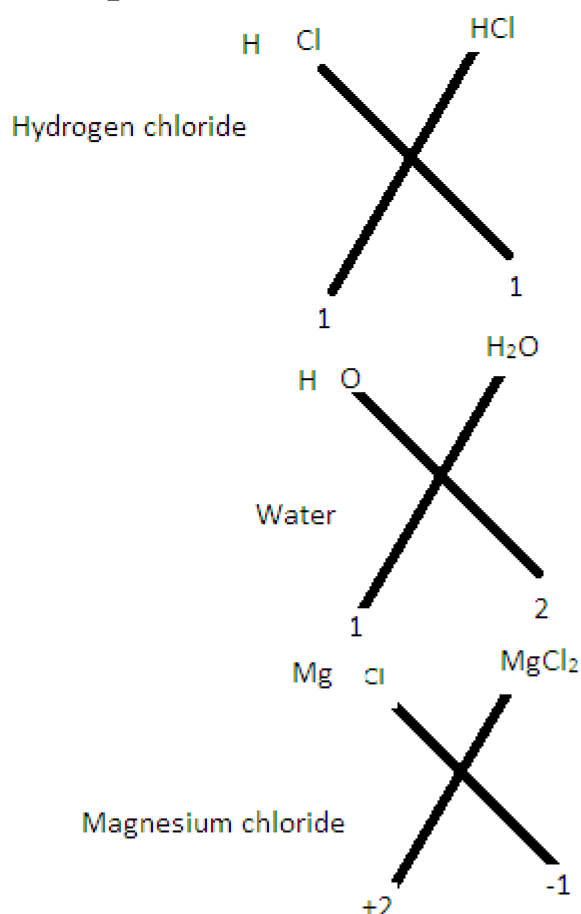
cation and the ion

carrying negative charge is called an *anion*.
Ionic compounds:- The compounds consisting of cations and anions are called as ionic compounds e.g. NaCl, $Al_2(SO_4)_3$.
Chemical formula of a compound: It represents the actual number of atoms of different elements present in the molecule of a compound e.g. CO_2, H_2O.
Chemical Formula of an Ionic Compound: It simply represents the ratio of cations and anions present in the
Structure of the compound e.g. NaCl.
Valency of an element: It is defined as the combining capacity of an element. It is equal to the number of
electrons lost, gained or shared by an element to acquire stability e.g.
CH4 + 4O → $C0_2$+$2H_2O$
Valency of an ion: It is defined as the units of positive or negative charge present on the ion e.g.

Rules for writing the chemical formula:

1. In case of simple molecular compounds, the symbols of the two elements are written side by side and their respective valencies are written below their symbols.
2. In case of simple ionic compounds i.e. compounds made up of monoatomic ions, the symbol of the metal atom forming the cation is written first followed by symbol of non-metal atom forming the anion and their respective valencies are written below their symbols.
3. In case of polyatomic ionic compounds, the formula of the polyatomic ion is written in brackets and the valencies are written below as in the above case.

4. In any of the above cases, if there is a common factor between the valencies of the cation and the anion, the valencies are divided by the common factor.
   Finally we apply criss cross i.e. cross over the valencies or the charges so that they appear on the lower right hand side of the symbols.
   However-1 appearing on the lower right hand side of the symbol is omitted. Similarly, +1 and signs of the charges of the ions are also omitted.
   Examples



Formula unit Mass: The formula unit mass of a substance is the sum of the atomic masses of all the atoms present in one formula unit of the compound e.g. formula unit mass of NaCl….. atomic mass of Na +

atomic mass of Cl 23 + 35.5 = 58.5u.

Gram atomic Mass: Atomic mass expressed in grams is called gram atomic mass of that element e.g. gram atomic mass of H is 1g, gram atomic mass of O is I6g

Gram molecular Mass: Molecular mass expressed in grams is called as gram molecular mass of that substance e.g. gram molecular mass of H_2 is 2.0g and that of O_2 is 32.0g.

Gram formula Unit Mass: Formula unit mass expressed in grams is called as gram formula unit mass. This
amount is called one gram formula unit e.g. gram formula unit mass of NaCl is58.5g.

Topic: Structure of atom

Discovery of electron,study of cathode rays ,discharge tube experiments:

The existence of electron in an atom was shown by J..J. Thomson in 1897 on the basis of detailed study of
cathode rays. The discovery of cathode rays was made on the basis ofdischarge tube experiments using airor some other gases inside the discharge tube.

Discharge Tube: It is a long glass tube. Two circular metal plates A and B are sealed at the two ends or tube. These plates are called electrodes. A side tube is also fused to the tube which can be connected to a vacuum pump to suck out the air or gas present inside the tube to reduce the pressure inside the tube.

Production of Cathode Rays: On applying high voltage (about 10,000 volts) between the electrodes, the results observed at different pressures of the air or gas inside the tube is as follows:

No flow Of Current At Ordinary Pressure: When the air inside the discharge tube is taken at normal atmospheric pressure and a voltage of about 10,000 volts is applied between the electrodes, no current flows through the air between the electrodes. This is because air or any gas at normal pressure is a poor conductor of electricity.

Glow In The Entire Tube At 1mm Pressure: If the air inside the tube is sucked out by connecting the side tube "S" to the vacuum pump so that the pressure falls to about 1 mm of mercury and now a voltage of about 10,000 volts is applied, the current begins to flow between the electrodes through the air inside and hence the entire discharge tube begins to glow uniformly with magenta red colour.

1) Glow Intercepted By Dark Bands At Lower Pressures: If the air inside the tube is sucked out so that pressure inside the tube further falls and high voltage is applied as before, the glow is intercepted by dark bands at the right angle to the axis of the tube.

2) Production Of Cathode Rays at 0.001mm Pressure: When the pressure of the air or the gas inside in the tube falls to about 0.00 I mm, the discharge tube appears dark i.e. there is no light emitted by the air. However, the glass wall of the tube exactly opposite to the cathode glows with a greenish-yellow light called fluorescence. This observation clearly shows that some invisible rays are coming iron from thecathode which travel in straight line and strike the glass wall opposite to the cathode. Since, these rayswere coming from cathode, these are called cathode rays.

Properties of Cathode Rays:

i) *Cathode rays travel in straight lines:* This is shown by the fact that if an object such as metal cross is
placed in the path of cathode rays, they cast a sharpshadow of the object at the back.

ii) *Cathode rays are made up of material particles:*This is shown by the fact that if a light paddle wheel isplaced in the path of cathode rays such that the cathode rays strike the blades of upper half, it begins torotate.

iii) Similarly, when a magnetic field is applied on the cathode rays, they are deflected in a direction which shows that they carry negative charge. They produce green fluorescence on the glass walls of the discharge tube as well as on certainsubstances such as zinc sulphide.

iv) Cathode rays produce heating effect.

v) They produce X-rays when they strike against the surface of hard metals like tungsten etc.

Electrons: The negatively charged material particles consisting of the cathode rays are called electrons. Charge on an electron is -1 unit.
Mass on an electron is negligible. 9.1×10^{-31}kg
1 /1840thof mass of hydrogen

Origin of Cathode Rays: The cathode rays are firstproduced from the material of the cathode.These then hit the gas atoms present in the discharge tube and knock out electrons (from the gas atoms). These electrons travel towards the opposite charged anode in the form of cathode rays.

Production Of Anode Rays: Since the atom as a whole is electrically neutral and the presence of negatively charged electrons in it has been confirmed beyond doubt.Therefore, it was thought that some positively charged particles must also be present in the atom. The existence of positively charged particles in an atom was shown by Goldstein in 1886. He took a discharge tube with a perforated cathode and a gas at low pressure inside the discharge tube. On applying high voltage, between the anode and the cathode, it is observed that just fluorescence was observed on glass wall of the tube at E due to cathode rays coming from the cathode, and
hit the wall at E. Fluorescence is also observed on the glass wall of the tube at F. This shows that some rays
coming from the side of the anode which passed through the holes in the cathode and then strike the glass of the tube at F. Since, these rays are coming from the side of the anode, therefore, they are called anode rays. They are also named as "canal rays" because they passed through the holes or canals in the

cathode. Further, their deflection in the electric field shows that they carry positive charge. Hence they are also called "positive rays".

Origin Of Anode Rays: Anode rays do not originate from the anode. They are produced in the space between the anode and the cathode. It is believed that the high electrical energy supplied between the electrodes splits up molecules of the gas present in the tube into atoms. The electrons present in these atoms further absorb electrical energy and are knocked out. The electrons thus knocked out travel towards anode and form a part of cathode rays. The remaining part of the atom becomes positively charged particle. These positively charged particles travel in the form of a stream towards the cathode (because it is a negatively charged electrode) and constitute anode rays.

Properties Of Anode rays:

The properties of anode rays have been studied by experiments similar to those of cathode rays. The main properties of anode rays are:

1) *Theytravel in straight lines:* This is shown by the fact that if an object is placed in their path, a shadow is produced at the back. However, their speed is much less than that of the cathode rays.
2) *They are made up of material particles*: This is shown by the fact that if a light paddle wheel mounted on an axle is placed in their path, it begins to rotate.
3) *They carry positively charge*: It is observed that the anode rays are deflected towards the negative plate of the electric field and produce fluorescence at 'F'. This shows that they carry positive charge. Mass of positively charged particles constituting the anode rays also depends upon the nature of the gas. The mass is found to be nearly equal to the mass of the atom of the gas.
4) Charge on the positively charged particles constituting the anode rays is also found to depend upon the nature of the gas and the voltage applied. However, the charge is found to be a whole number multiple of the charge present on the electron. It may be +1, +2, +3 units depending upon the number of electrons knocked out of the gaseous atom.

Q) What is a proton?

A) A proton is defined as the sub-atomic or fundamental particles which carries one unit positive charge and has mass nearly equal to that of hydrogen atom.

Charge on proton = +1. It is represented by the symbol p, mass of proton is 1.67×10^{-27}.

Bohr's Model of Atom:

In order to overcome the drawbacks of Rutherford's model of the atom, Neil Bohr put forward a new model of atom in 1913. Its main postulates are:

1. An electron in an atom revolves around the nucleus only in a definite circular orbits. These orbits are associated with definite amounts of energies and are called energy shells or levels. These are numbered as 1, 2, 3, 4.......and designated as K , L , M , N.......
2. As long as electron remains in a particular orbit, it neither gains nor looses energy. These orbits are therefore called stationary states.
3. The angular momentum of an electron revolving around the nucleus is fixed (quantized) and is equal to

$$mvr = \frac{nh}{2\Pi}$$

where m is mass of electron, v is the velocity of electron.
ris radius of orbit, h is Planks constant and 6.626×10^{-34}
Energy is absorbed or emitted only when the electron changes its state.

4. Energy is absorbed or emitted only when the electron

jumps from one orbit to another i.e. from ground state to excited state. The energy emitted or absorbed is given by

$\Delta E = E2 - E1 = Hv$

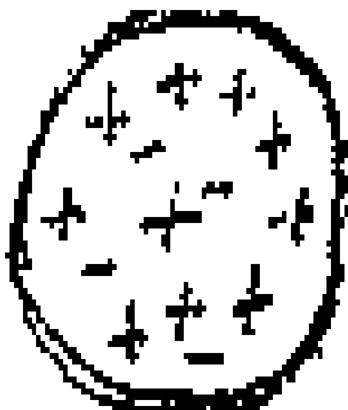
$$V = \frac{E2 - E1}{}$$ Equation for frequency of emitted radiation

Where ΔE is Change in energy
$E_2$is Level having higher energy. $E_1$is Level having lower energy.

Usefulness Of Bohr's Model Of Atom

According to Bohr's Model, as electrons cannot radiate energy while revolving in discrete orbits, therefore, it explains the stability of the atom i.e. it explains drawback of Rutherford's model of atom.

Thomson's Model of an Atom: In 1909. J.J. Thomson proposed that an atom is like a positive sphere in which electron are embedded that are sufficient to neutralize the positive charge. This maybe compared with a watermelon in which seeds are embedded. This model of an atom is called Thomson's Model. However, it could not explain the results of scattering experiments carried out by the Rutherford in 1911 and hence was rejected.



Rutherford's Model of the Atom:

Rutherford in 1911, performed some experiments in which he bombarded a thin foil of a heavy metal like gold with a beam of fast moving alpha particles which aredoubly charged helium ions (He2+) each having two units of a positive charge and four units of mass (4u). These were obtained from radium placed in the cavity of a block of lead and made into a fine beam with a slit . He observed the scattering of the alpha-rays after hitting the foil by placing a circular zinc sulphide screen around the metal foil. Wherever alpha particles strike the screen, a flash of light is produced at that point on the screen.

Observations:

1. Most of the alpha-particles (99.0%) passed straight through the foil without undergoing any deflection.
2. Some of the alpha-particles were deflected through small angles and a few were deflected through large angles.
3. Very few only one in 12000 were deflected back.

Conclusions: From the α-particle scattering experiment Rutherford concluded that:

1. Most of the space inside the atom is empty because most of the α-particles passed straight through the gold foil without getting deflected.
2. A nucleus is present at the centre of an atom which is positively charged because few of the α-particles were deflected or rebounded back.
3. The size of nucleus is very small as compared to the total volume of atom because very few α-particles were deflected.
4. Whole mass of atom (atomic mass) is concentrated in the nucleus.

On the basis of his experiment, Rutherford put forward his model of atom which stated that:

1. There is a positively charged centre in an atom called the nucleus.

Nearly whole mass of atom is concentrated in the centre.

2. The electrons revolve around the nucleus in well-defined orbits.
3. The size of the nucleus is very small as compared to the size of the atom.

Final model given By RutherfordAbout Atoms:

On thebasis of scattering experiments, Rutherford put forward a model of atom known as Rutherford's nuclear model. The main points are as follows:

1. An atom consists of two parts: a) nucleus b) extra nuclear part.
2. Nucleus is a small heavy positively charged body present in the centre of the atom.
3. Extra nuclear part means the space around the nucleus in which electrons are present.
4. The entire mass of the atom is concentrated in the nucleus. Since the electrons have negligible mass.
   The mass of the atom is mainly due to the protons.
5. Toexplain that the electrons do not fall into the nucleus as a result ofattraction. Rutherford suggested

that electrons were not stationary but were revolving around the nucleus in certain orbits. As a result,
centrifugal force comes into play which balances the force ofattraction.

Drawbacks of Rutherford's model of the atom:

Rutherford could not explain the stability of an atom. This is because according to the Rutherford's model, an atom consists of a small heavy positively charged nucleus in the centre and the electrons were revolving around it. However, when a charged particle like electron is revolving around a central force like that of nucleus, it loses energy continuously in the form of radiations. Thus, the orbit of the revolving electron will keep on becoming smaller and smaller, following a spiral path and ultimately the electron should fall into the nucleus. In other words, the atom should collapse. However, this actually doesn't happen and the atom is quite stable.

Discovery of Neutron: Reason for the discovery of neutrons in an atom: The mass that was calculated after the number of protons was found to be less than the actual mass of atom. So, it was suggested by Rutherford in 1920 that there must be some neutral particles with definite mass present in the nucleus.

Experimentsleading to the discovery of neutron: The existence of neutron in the nucleus was confirmed by Chadwick in 1932. He bombarded the nuclei of some light elements like Beryllium and Boron with fast
moving α-particles. He found that some neutral particles were ejected from

the nucleus. Each of these particles carries no charge but had a mass nearly equal to that of proton (1.67×10^{-27} kg). This particle was named as neutron.

Neutron:

It may be defined as that sub atomic particle which carries no charge, i.e. neutral particle having mass nearly equal to that of the proton.

Composition of Atom

Electron:

Charge -ve(-1.602×10^{-19}coloumb)

Mass= 9.1×10^{-31}kg

Location☐ extra nuclear part

Symbol☐$^{0}e_{-1}$

Proton:

Charge:

+ve(1.602×10^{-19}coloumb)

Mass: 1.673×10^{-27} kg

Location : Nucleus

Symbol: $^{1}p_{1}$

Neutron:

Charge: No charge

Mass: 1.675×10^{-27} kg

Location: Nucleus

Symbol: $^{1}{}_{0}n$

Atomic Number:

It is equal to the number of protons present in the nucleus of the atom of an element or no. of electrons in the extra nuclear part. Itis denoted by Z

Characteristics of Atomic Number:

1. It is always a whole number.
2. All the atoms ofthe same element have same numberof protons in the nucleus and hence have the sameatomic number.
3. No two elements have the same atomic number.
4. It does not change during the chemical reaction.

MassNumber: It is the sum ofthe number of protons and neutrons present in the atom of an element.

Massnumber = Number of protons + number of neutrons. It is denoted by A.

1. **<u>Distribution of electrons in different shells/Electronic Configuration of Elements:</u>**
   a. Thedistribution or arrangement ofthe electrons in the different shells ofthe atom is called the electronic configuration of the

element.

b. To write the electronic configuration of an element, we should know the following:

i) Total number of electrons present in the atom.This is equal to the number of protons (i.e. atomic number) for a neutral atom.

ii) Maximum number of electrons that can be present in each shell of the atom. This is given by BohrBury Scheme as follows:

The maximum number of electrons that can be present in the nth shell is equal to $2n^2$. Thus we have

Shell	Maximum Number of electrons present
I shell or K-shell (n- 1)	$2 \times 1^2 = 2$
II shell or L-shell (n- 2)	$2 \times 2^2 = 8$
III shell or M-shell (n- 3)	$2 \times 3^2 = 18$
IV shell or N-shell (n-4)	$2 \times 4^2 = 32$

ii. The outermost shell cannot have more than eight electrons even if the first rule is violated e.g. III shell (M-Shell) can accommodate upto 18 electrons but as soon as it has acquired 8 electrons, the filling ofthe IV shell (N-Shell) starts. Thus, for the first 18 elements, rule (iii) can be applied.

iii. Electrons do not enter into a new shell unless the inner shells are completely filled. In other words, the shells are filled in a stepwise manner.

ValenceElectrons AndValency

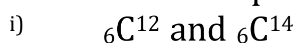
1. The electrons present in the outermost shell ofthe atom of an element are called valence electrons.Theoutermost shell is called the valence shell.
2. The number of electrons gained, lost or shared by the atom of an element so as to complete its octet (or duplet in case of elements having only K-shell) is called the valency ofthe element.
3. Calculation Of Valency:

1. For elements having valence electrons 1, 2 or 3 valency is equal to the number of valence electrons.
2. For elements having valence electrons 4,5,6 or 7, valency is equal to the number of electrons to be added so that the valence shell has 8 electrons.

   Valency=8-(number of valence electrons).
3. For noble gases, valency is zero: This is because they are chemically inert i.e. they do not take part in the reaction. Noble gases have 8 valence electrons .

Isotopes:

Atoms of an element having the same atomic nobut different mass numbers are known as isotopes of that element. For example:

i) 
$_6C^{12}$ and $_6C^{14}$

ii) 
$_{17}C^{35}$ and $_{17}C^{37}$

iii) 
$_1H^1$ and $_1H^2$ or $_1H^3$

Chlorine occurs in two isotopic forms in nature, with masses 35u and 37u in the ratio of 3: 1.The average atomic mass of Cl-atom is:

Ratio: 75/100 and 1/100

=35x(75/100) +37x(25/100)

$$\frac{105}{4} + \frac{37}{4} = \frac{142}{4} = 35.5u$$

Average mass of chlorine is 35.5u

General Characteristics of Isotopes:

1. Same atomic number i.e. number of protons=number of electrons.
2. Different mass number/number of neutrons.
3. Same chemical properties.
4. Different physical properties
5. Different nuclear properties

Uses / Applications of Isotopes:

Some important uses ofisotopes are:

1. An isotope of uranium (U_{235}) is used as fuel in nuclear reactors to produce energy.
2. An isotope of carbon (C-14) is used to determine the age of old and dead objects.
3. An isotope of cobalt is used in the treatment of cancer.
4. An isotope of iodine is used in the treatment of goitre.

Types of Isotopes:

i) *Radioactive isotopes*: These isotopes are unstable and spontaneously breakdown and give out α (alpha), (Beta) (Gamma) rays

ii) *Non-radioactive isotopes*: These isotopes are stable:e.g.$_1H^1$, $_1H^2$ and $_{11}Na^{23}$.

Isobars:

Atoms of different elements having same atomic mass but different atomic no.s are called isobars like atoms of calcium and potassium.

General characteristics of isobars:

1. They are atoms of different elements.
2. They have different atomic number.
3. They have same mass number.
4. They possess different physical and chemical properties.
5. They have different number of protons, electrons and neutrons.

Reason For Fractional Atomic Masses and Calculation of Average Atomic Masses:

Atomic masses of a large number of elements are fractional and not whole number e.g. atomic mass of chlorine is 35.5 while that of copper is 63.5. The reason for the fractional atomic masses is that for an element existing in different isotopes i.e. atoms with different mass numbers, the atomic mass of the elements is the average value which comes out to be fractional. The calculation of average value of the atomic mass may be illustrated with the help of following example: chlorineis found to exist in 2 isotopes with mass numbers 35 and 37 respectively. These are found in the ratio of 3:1 i.e. 75% chlorine-35 and 25% chlorine-37 isotope. Hence,

Average atomic mass = (¾) x 35 +37x(1/4) = 35.5 amu

Q) If K and L shells of an atom are full, then what .....

A) If K and l shells of an atom are full, it means | K L M N |

2.8

And number of electrons is 10.

Q) Compare the properties of electrons, protons .....

Property	Electron	Proton	Neutron
Symbol	e or $_{-1}e^{0}$	P or $_{1}H^{1}$	N or $_{0}n^{1}$
Relative charge	-1	+1	0
Rel. mass inamu	1/1837	1	1
Electric behavior	Attracts towards +ve plate	Attracts towards -ve plate	Unaffected
Position within atom	Outside the nucleus	Inside the nucleus	Inside nucleus

Q)What are the limitations of Thomson's Model of Atom?

The limitations of Thomson's model of atom are:

1. He considered atom to be a sphere such that electrons are embedded in it.

2. He was unaware of the fact that electron revolves around the nucleus in a orbit.
3. He was unaware of the presence of neutrons in the nucleus of atom.
4. He was unaware about the position of nucleus in the atom.

Q) Na^+ means that sodium has last one electron……

a) In neutral state, sodium shows an
electronic configuration of Na(Z =11) K L M N
2 8 1

Butfor Na^+ , it is like: K L M N
2 8 0

It indicates that sodium is quite stable as Na^+ because K and L shells are completely filled and the one electron which was (present in M shell) that was making it unstable is lost by Na to achieve stable configuration.

Q) If Br-atom is available in the form of two…..

A) For $_{35}B^{79}$

%age 49.7%

50% andFor

$_{35}Br^{81}$ %age

50.3 % 50%

Average atomic mass =

79x50/100 + 81 x 50/100= 79/2 + 81/2= 160/2= 80u.